DFB fiber laser as source for optical communication systems

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Published in:
Optical Fiber Communication. OFC 97., Conference on

Link to article, DOI:
10.1109/OFC.1997.719791

Publication date:
1997

Document Version
Publisher's PDF, also known as Version of record

A highly nonlinear fiber has been fabricated by increasing the nonlinear refractive index by ~1.5 times and decreasing the effective area by ~3× over commercial DS fiber. A NOLM formed with this fiber demonstrates improved switching of 1.1 pJ switching in 2 km. For high-speed TDM applications, average control powers are well within current amplifier technology.

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DFB fiber laser as source for optical communication systems

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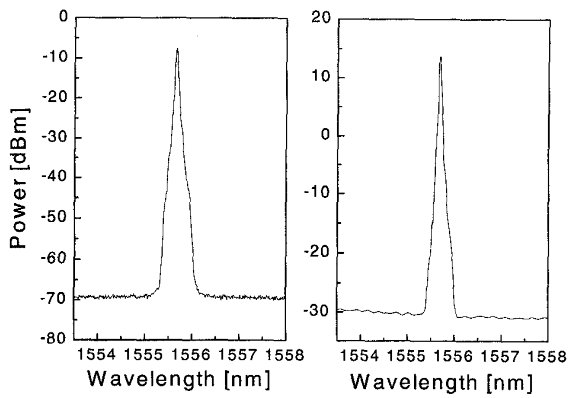
Distributed Bragg reflector (DBR)[1] and distributed feedback (DFB)[2–4] fiber lasers based on UV-induced Bragg gratings in active fibers are high-quality light sources, which may provide robust single-mode operation without mode hopping. Therefore they constitute an attractive alternative to semiconductor laser sources for optical communication systems. In addition, our DFB fiber lasers offer stable linear polarization with ~15 kHz linewidth, excellent signal-to-noise ratio and high-temperature stability.

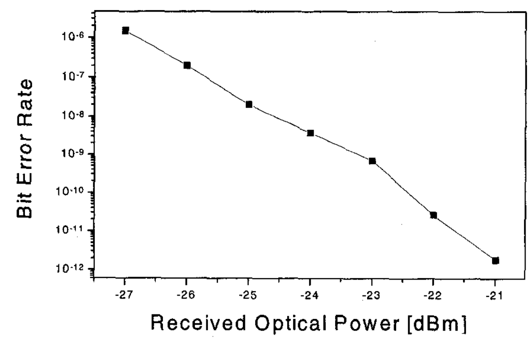
In the experiment we used 5 cm of Er^{3+}:Ge:Al codoped silica fiber (manufactured by Lycom A/S) spliced to standard fiber pigtails equipped with angled connectors. The Bragg gratings were photoinduced using a KrF excimer laser illuminating the fiber with 248-nm light through a 5-cm-long phasemask (fabricated by QPS). The induced grating is 4.6 cm long and has a peak reflectivity of 99% at 1555.6 nm. A phase shift was induced in the central part of the grating by additional UV-exposure. The grating was pumped by a semiconductor laser giving 60 mW output around 1475 nm. The lasing was monitored using an optical spectrum analyzer. A scanning Fabry-Perot interferometer was used to verify single-mode operation. Single-mode operation without mode hopping was observed continuously from room temperature up to 200°C and also at −196°C.

The laser has a peak wavelength of 1555.6 nm and a signal-to-noise ratio of 61 dB, measured with a 0.05-nm resolution (left part of Fig. 1). The signal power was 150 μW with 60-mW pumping. When amplifying the laser with a commercially available booster amplifier a signal power of 22 mW was achieved with a signal-to-noise ratio of 44 dB (right part of Fig. 1).

To prove the long-term stability of the laser a transmission experiment at a bit rate of 10 Gbit/s was carried out. The laser was put in a block of aluminum, which was mounted on an optical table. Further temperature stabilization was not necessary as the wavelength drift due to temperature is as low as 0.01 nm/K. The laser was modulated with a $2^{31} - 1$ nonreturn to zero (NRZ) pseudorandom bit sequence using a Mach-Zehnder modulator controlled by a 10-Gbit/s transmission error test set. The signal was transmitted over 49.5 km of standard telecommunication fiber with a total loss of 10 dB. The bit-error-rate (BER) curve was measured (Fig. 2) and error-free operation was observed during a measurement time of one hour.



WL7 Fig. 1. Signal-to-noise ratio of DFB fiber laser, measured with a resolution of 0.05 nm. The left figure shows the output directly from the laser and the right figure shows the amplified signal.



WL7 Fig. 2. 10-Gbit/s BER curve for amplified DFB fiber laser transmitted through 49.5-km standard single-mode fiber.

The results demonstrate that DFB fiber lasers are an attractive alternative as sources in telecommunication systems. The lasers show excellent long-term stability with very high signal to noise ratio and a reasonable output power, combined with exceptional temperature stability and inherent fiber compatibility.

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